

January 18, 2012

Mr. Jack M. Davis
Senior Vice President and Chief Nuclear Officer
Detroit Edison Company
Fermi 2 – 210 NOC
6400 North Dixie Highway
Newport, MI 48166

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 70 RELATED TO
CHAPTERS 2.0 AND 3.0 FOR THE FERMI 3 COMBINED LICENSE APPLICATION

Dear Mr. Davis:

By letter dated September 18, 2008, Detroit Edison Company (Detroit Edison) submitted for approval a combined license application pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52. The U.S. Nuclear Regulatory Commission (NRC) staff is performing a detailed review of this application to enable the staff to reach a conclusion on the safety of the proposed application.

The NRC staff has identified that additional information is needed to continue portions of the review. The staff's request for additional information (RAI) is contained in the enclosure to this letter. To support the review schedule, you are requested to respond within 30 days of the date of this letter. If changes are needed to the safety analysis report, the staff requests that the RAI response include the proposed wording changes.

If you have any questions or comments concerning this matter, I can be reached at 301-415-8148 or by e-mail at jerry.hale@nrc.gov.

Sincerely,

/RA/

Jerry Hale, Project Manager
Licensing Branch 3
Division of New Reactor Licensing
Office of New Reactors

Docket Nos. 052-033

eRAI Tracking No. 6217, 6243, 6244, 6245 and 6247

Enclosure:
Request for Additional Information

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Dear Mr. Davis:

By letter dated September 18, 2008, Detroit Edison Company (Detroit Edison) submitted for approval a combined license application pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52. The U.S. Nuclear Regulatory Commission (NRC) staff is performing a detailed review of this application to enable the staff to reach a conclusion on the safety of the proposed application.

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Enclosure:
Request for Additional Information

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***Approval captured electronically in the electronic RAI system.**

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Request for Additional Information No. 6217

Fermi Unit 3
Detroit Edison
Docket No. 52-033
SRP Section: 02.05.02 - Vibratory Ground Motion

Question: 02.05.02-17

FSAR Sections 2.5.2.5.1.3 and 3.7.1.1.4.1.1.3 describe the randomized shear wave velocity profiles used in the site response analyses to account for variations in these profiles. The correlation model described (FSAR Reference 2.5.2-286; Silva et.al, 1996) is the model developed from analyses of shear wave data taken at the Savannah River Site, a relatively deep soil site (composed primarily of sands, silty sands, and silts) of approximately 800 ft to 1,000 ft depth over hard rock. Explain why such a model is appropriate for use at the Fermi site. What is the impact of this assumed correlation model on site amplification? If a fully correlated model were to be assumed, for example, what would be the expected increase in amplification, particularly at higher frequencies above 15 Hz?

Question: 02.05.02-18

FSAR Section 2.5.2.5.2 indicates that the selected time histories were scaled to approximately match the target DE spectrum using a limited number of iterations of the program RASCALS. Please provide more detail regarding the scaling process. In addition, please quantitatively compare the mean response spectrum of each suite of scaled time histories to the respective target spectrum.

Request for Additional Information No. 6243

SRP Section: 03.07.02 - Seismic System Analysis

Application Section: 03.07.02

Question: 03.07.02-5

ESBWR DCD Tier 2 Section 3.7.2.8 identifies the following:

- Turbine Building (TB), Service Building (SB), and Ancillary Diesel Building (ADB), as Seismic Category II structures, are to be analyzed using the same methods as Seismic Category I structures (including structure-soil-structure interaction with adjacent Seismic Category I structures) for full SSE loads.
- The Radwaste Building (RW), as an RW-IIa structure per RG 1.143, is also to be analyzed using the same methods as Seismic Category I structures (including structure-soil-structure interaction with adjacent Seismic Category I structures) for full SSE loads.
- Seismic input motions for the Seismic Category II structures are based on the design spectra defined in DCD Table 3.7-2 with the applicable scale factors applied at the corresponding foundation level at the bottom of the base slab. The scale factors are based on the assumed DCD soil properties.
- Seismic gaps between the non-Seismic Category I structures listed above and the Seismic Category I structures are no less than the calculated maximum relative displacements between the structures during an SSE event.

ESBWR DCD Tier 1 Section 2.16 includes the following ITAAC to ensure that the above analysis and design commitments are met:

- Table 2.16.8-1, Item 1 (TB): The TB analysis and design is the same as a Seismic Category I structure, including the load combinations and the acceptance criteria, for loads associated with:
 - Natural phenomenon – wind, floods, tornadoes (excluding tornado missiles), earthquakes, rain and snow. In addition, the TB is designed for hurricane wind to protect RTNSS systems.
 - Normal plant operation — live loads and dead loads.
- Tables 2.16.9-1, 2.16.10-1, and 2.16.11-1 have similar design commitments for the RW, SB, and ADB.

In EF3 FSAR Section 3.7.2.8, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, the applicant states that Fermi 3 site-specific analysis will be performed for the Seismic Category II structures if referenced DCD backfill requirements are not met. Since the backfill requirements are not being met for the Fermi 3 site, the applicant is requested to describe in the FSAR how the above ESBWR DCD commitments and ITAAC are implemented for the site-specific conditions of the Fermi 3 site, including a description of the site-specific analysis to be performed. The applicant is also requested to describe how the seismic input for the Seismic Category II structures (for the site specific analysis) will consider the site-specific scale factors, including the effect of structure-soil-

structure interaction, to ensure that the seismic input specified in the DCD for these structures will still be bounding.

In addition, explain why EF3 FSAR Figures 2.5.4-201 through 2.5.4-204, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, only show the TB and RW, and not the SB and ADB, and why Table 2.5.4-224 lists the TB as “nonseismic” and not as Seismic Category II.

Question: 03.07.02-6

EF3 FSAR Sections 3.7.1, 3.7.2, and 3.8.5, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, indicate that engineered granular backfill above the Bass Islands Group rock is not included in the site-specific SSI analyses performed for the RB/FB and CB. The rationale given for exclusion of the backfill is that it is not credited for resistance of sliding and overturning forces, and thus serves no safety-related function. It is also implied that, because the site-specific SSI analyses “do not take credit for the benefits provided by the backfill surrounding the RB/FB and CB” (EF3 FSAR Section 3.7.2.4.1), the computed SSI responses (seismic loads, vertical accelerations, and in-structure response spectra) are appropriate for comparison to the reference ESBWR DCD design values.

However, EF3 FSAR Figures 2.5.4-201 through 2.5.4-204 show that the RB/FB and CB are deeply embedded structures with two-thirds or more of their depth in the granular fill (above rock and concrete). As such, the applicant is requested to provide further justification for ignoring embedment effects on SSI response. The justification should include the potential impact of this modeling approach on in-structure response spectra (over the entire frequency range of interest), lateral wall pressures, and other seismic loads.

Question: 03.07.02-7

The Defense Nuclear Facilities Safety Board has recently identified a technical issue with the SASSI2000 code, concerning the use of the subtraction method for SSI analysis of embedded structures. To address this issue, during the Public Meeting held July 21, 2011, GEH made a presentation showing comparisons of SSI response between the direct and subtraction methods of SASSI2000 (see ADAMS Accession Number ML112020435). The presentation indicated that SSI analyses for the CB were performed using both methods. Comparisons in terms of transfer functions and floor response spectra at the CB roof and basemat appear to indicate very close agreement between the two methods. However, the presentation did not provide figures that show the excavated volume. The applicant is requested to provide the geometry and properties of the excavated volume modeled in both SASSI analyses.

Considering that the RB/FB has a significantly larger footprint and is more deeply embedded than the CB (i.e., significantly larger excavated volume), it may not be possible to extrapolate the comparison results for the CB to the RB/FB. Therefore, the applicant is requested to provide an additional comparative study for the RB/FB along the lines of the study performed for the CB.

Details of the comparative studies discussed above should be included in the relevant sections of the EF3 FSAR.

Question: 03.07.02-8

ESBWR DCD Appendix 3A.8.11 describes the SSI analyses performed to evaluate the structure-soil-structure-interaction (SSSI) effects of the RB/FB on the CB, and the effects of the CB on the FWSC. These analysis cases are termed CL-6 and FL-5 in the ESBWR DCD. Based on these limited analysis cases, it was concluded that SSSI effects were bounded by other analysis cases and would not affect the ESBWR DCD design envelope.

EF3 FSAR Figure 2.5.4-202, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, shows a cross section through the RB/FB, CB and FWSC with the extent of concrete fill and granular fill. Since these site conditions deviate significantly from cases CL-6 and FL-5, analyzed in the ESBWR DCD, the applicant is requested to explain how SSSI effects are evaluated between these structures. What is the basis for neglecting the granular fill in the site-specific analyses in the context of SSSI, given that these structures are deeply embedded and in close proximity to each other? What is the basis for including concrete fill between the RB/FB and CB gap? Does the addition of the stiff concrete fill between the CB and the RB/FB introduce potential interaction between the two structures?

Request for Additional Information No. 6244

SRP Section: 03.07.01 - Seismic Design Parameters

Application Section: 03.07.01

Question: 03.07.01-3

EF3 FSAR Section 2.5.4.5 and Figure 2.5.4-202, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, indicate that the lateral extension of concrete fill under the FWSC is limited to its footprint. Explain why it is appropriate to define the FIRS for this facility on the basis of a 1D column of concrete material if the lateral extension of this material is limited to its footprint.

Question: 03.07.01-4

The shear wave velocity of concrete fill assumed in the site response analyses described in EF3 FSAR Section 2.5.2 is $V_s = 3600$ fps (EF3 FSAR Table 2.5.2-220). However, as indicated in the response to RAI Letter 55 Question 02.05.04-38, to address potentially aggressive soil and groundwater conditions, the concrete fill will have a minimum compressive strength of 4500 psi, which corresponds approximately to $V_s = 7100$ fps (based on standard equations, concrete density 145 lb/ft^3 , and Poisson's ratio of 0.2). It is also noted that measured velocities of lean concrete placed at the Oak Ridge site, for example, were significantly higher than the assumed 3600 fps.

Therefore, explain the impact of the increased shear wave velocity on the computed FIRS for the FWSC, particularly at high frequency. Also explain how the data from EF3 FSAR Reference 2.5.2-288 (Hasek, 2002), which is based on lean concrete with shear wave velocities between 900 fps and 1400 fps, is applicable to the aforementioned Fermi 3 site conditions.

Question: 03.07.01-5

EF3 FSAR Figures 2.5.4-201 through 2.5.4-204, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, show the lateral extent of the engineered granular backfill surrounding the RB/FB, CB, FWSC, and other Seismic Category II structures. As shown in EF3 FSAR Figure 2.5.4-201, the backfill extends to a perimeter diaphragm wall that is used to support the excavation of in situ material. Beyond the diaphragm wall, it appears that in situ soils (fill and glacial till) will remain in place.

Since the backfill material is limited in lateral extent, following a relatively complicated geometry in plan, explain why it is appropriate to define the PBSRS and FIRS for the RB/FB and CB (EF3 FSAR Section 3.7.1) on the basis of a 1D column of backfill material.

Question: 03.07.01-6

EF3 FSAR Section 3.7.1.1.5, Table 3.7.1-212, and Table 3.7.1-212, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, indicate that the two horizontal components of spectrum-compatible ground motion used in the seismic SSI analysis have correlation coefficients slightly under 0.30. This deviates from the guidance in SRP 3.7.1, which states that the three orthogonal components of ground motion are considered to be statistically independent if their correlation coefficient is less than 0.16.

The applicant in EF3 FSAR Section 3.7.1.1.5 further explains that the deviation from the guidance in SRP 3.7.1 is based on a recommendation from NUREG/CR-6728; however, this reference document does not provide a technical basis for this recommendation.

Regulatory Guide (RG) 1.92 provides further guidance for combining the spatial components of the earthquake motion. Per this RG, if the three components of earthquake motion are statistically independent, then the maximum response of interest of an SSC can be obtained from algebraic summation of the three component responses at each time step (Regulatory Position C.2.2(2)). Alternatively, the three spatial components can be calculated separately and the response of interest can be combined by taking the SRSS of the maximum component responses (Regulatory Position C.2.2 (1)).

Based on the above discussion, the staff needs additional technical basis for using two components of ground motion with correlation coefficient of approximately 0.30. If Regulatory Position C.2.2(2) of RG 1.92 is used for determining the total site-specific seismic demand for the SSCs, the applicant is requested to provide a comparison with the seismic demand as determined from the use of Regulatory Position C.2.2(1), and demonstrate that the current site-specific seismic demand as specified in EF3 FSAR is not under predicted.

The staff notes that, according to ESBWR DCD Table 3.7-3, which has been incorporated by reference into the EF3 FSAR, the seismic analysis of all Seismic Category I structures follows Regulatory Position C.2.2(2) (i.e., "Algebraic Sum" is specified under the column "Three Components Combination"). This is acceptable only when the three components of the earthquake motion are statistically independent.

Question: 03.07.01-7

EF3 FSAR Section 3.7.1.1.5, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, indicates that the KAU078 recording of the Chi-Chi, Taiwan earthquake was used as the seed for generating artificial time histories, which are subsequently modified for input to the site-specific SSI analysis. It also indicates that this record set was selected because it is representative of a distant recording of a large magnitude earthquake, consistent with the large contribution of the New Madrid source to the seismic hazard at the Fermi 3 site. It further states that "the PGV/PGA values would be lower than those for large, distant earthquakes as the PGA is enriched to represent smaller magnitude, closer earthquakes." However, based on the information provided in EF3 FSAR Tables 3.7.1-211 and 3.7.1-214, it appears that PGV/PGA values for the artificial time histories are higher than the selected seed time histories, for the two horizontal components.

SRP Acceptance Criteria 3.7.1.II.1B also specifies that PGV/PGA should be consistent with the characteristic values for the controlling earthquake. As such, the applicant is requested to provide further justification of the acceptability of the PGV/PGA values for the artificial time histories being higher than the selected controlling earthquake. The applicant is also requested to provide comparison of the response spectra of the artificial time histories and the estimated target spectra (SSI FIRS) at 2 percent and 10 percent damping values for RB/FB and CB.

Question: 03.07.01-8

EF3 FSAR Section 3.7.1.1.4.6 and Table 3.7.1-210, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, indicate that the PGA for the RB/FB and CB horizontal FIRS are higher than 0.1g. It is implied that this is sufficient to meet the requirements in 10 CFR Part 50, Appendix S, for minimum horizontal ground motion at the foundation level in the free-field.

However, the guidance in SRP 3.7.1 and ISG-017 also indicates that, to satisfy the regulatory requirements, the minimum horizontal PGA of 0.1g should correspond to a smooth broad-band spectral shape such as the one described in RG 1.60. Therefore, the applicant is requested to provide in the FSAR comparison plots of the RB/FB and CB horizontal FIRS with the RG 1.60 horizontal spectrum anchored at 0.1 g, which demonstrate that the RB/FB and CB horizontal FIRS envelope the RG 1.60 spectrum at all frequencies of interest. The staff needs this information to confirm that the site-specific seismic input used in the site-specific SSI analysis meets 10 CFR Part 50, Appendix S.

Request for Additional Information No. 6245

SRP Section: 03.08.05 - Foundations
Application Section: 03.08.05

Question: 03.08.05-1

EF3 FSAR Table 1.9-204, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, references the 2006 edition of ACI 349. However, ESBWR DCD Tables 3.8-6 and 3.8-9 reference the 2001 edition of ACI 349. The applicant is requested to provide justification for using 2006 code edition of ACI 349.

Question: 03.08.05-2

EF3 FSAR Section 3.8.5.5.1, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, discusses the site-specific seismic stability evaluations performed for the RB/FB, CB, and FWSC at the Fermi 3 site. It is indicated that the stability evaluations for overturning, sliding, and flotation are performed using the methodology described in ESBWR DCD Section 3.8.5.5. In particular, the calculated factors of safety against sliding are 5.48 and 3.09 for the RB/FB and CB, respectively. However, it is not clear how the resisting forces needed to calculate these factors of safety were computed.

To determine whether the stability evaluations are consistent with the methodology described in the ESBWR DCD, provide the following information for the RB/FB and CB:

- (a) Provide the numerical values for each of the terms in the equation used to evaluate the factors of safety against sliding (see ESBWR DCD Section 3.8.5.5). Also provide a detailed explanation of how each value was obtained, including the assumed coefficient of friction at the various foundation-rock interfaces.
- (b) Explain if shear keys are provided as described in ESBWR DCD. The staff notes that EF3 FSAR Figures 2.5.4-201 through 2.5.4-204 do not show shear keys.

Question: 03.08.05-3

In the stability evaluations described in EF3 FSAR Section 3.8.5.5.1, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, it is assumed that the RB/FB and CB are partially embedded in rock, ignoring the backfill. Therefore, it is assumed that seismic base shears and overturning moments are transferred from each structure to the rock by a combination of friction and bearing pressure at the various foundation-rock interfaces.

EF3 FSAR Figure 2.5.4-202, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, indicates that stiff concrete fill is placed in the bottom portion of the gap between the RB/FB and CB, up to elevation 552 ft approximately. The applicant is requested to explain how the seismic load (in the E-W direction) imposed by the CB bearing against the concrete fill is transferred to the underlying rock. Is base friction sufficient to resist the entire load or will a certain fraction of this load be transferred to the adjacent RB/FB? Has this been considered in the design?

The above questions are also appropriate to the potential transfer of seismic loads from the RB/FB to the CB through the concrete fill.

Question: 03.08.05-4

EF3 FSAR Section 2.5.4.10.3 discusses static and dynamic lateral earth pressures for the RB/FB and CB below-grade walls at the Fermi site. At rest-conditions are assumed, consistent with the assumptions in ESBWR DCD Section 3.8.5 and Appendix 3G. These pressures are shown in EF3 FSAR Figures 2.5.4-230 and 4-231. However, no discussion is given regarding the lateral pressures on the portions of below-grade walls that are embedded in rock. Also, no discussion is given regarding additional lateral pressures due to: (i) static and dynamic surcharge loads from adjacent Seismic Category I and II structures; and (ii) effects of structure-to-structure interaction through the surrounding backfill, concrete fill, or rock.

The staff notes that the methodology used to estimate seismic lateral earth pressures is based on EF3 FSAR Reference 2.5.4-247 (Ostadan and White, 1998), which deviates from the methodology used in the ESBWR DCD Section 3.8.5, Appendix 3A, and Appendix 3G (envelope of the method described in ASCE 4-98 Section 3.5.3.2 and pressures obtained from the SSI analysis) and also from the guidance in SRP 3.8.4.II.4H.

To determine whether the lateral pressures for the RB/FB and CB below-grade walls at the Fermi site are bounded by those considered in the ESBWR DCD, provide the following information:

- (a) Comparison of seismic lateral earth pressures shown in EF3 FSAR Figures 2.5.4-230 and 4-231 with those obtained using the method described in ASCE 4-98 Section 3.5.3.2 and also with those given in ESBWR DCD Tables 3A.8.8-1 and 3A.8.8-2, and ESBWR DCD Sections 3G.1.5.2.1 and 3G.2.5.2 (Figures 3G.1-19, 3G.1-27, 3G.2-12, and 3G.2-15), which were used for the design of the walls.
- (b) For the portions of below-grade walls that are embedded in rock, provide estimates of the seismic lateral pressures imposed by the surrounding rock, which are compatible with the results of the site-specific SSI analyses performed and with the assumptions of the sliding stability calculations discussed in EF3 FSAR Sections 3.7.2 and 3.8.5, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38.
- (c) Provide estimates of additional static and dynamic lateral pressures imposed from adjacent Seismic Category I and II structures. This should also include possible effects of structure-to-structure interaction through the surrounding backfill, concrete fill, or rock.
- (d) Modify EF3 FSAR Figures 2.5.4-230 and 4-231 to incorporate the pressures discussed in items (b) and (c) above and compare with the lateral pressures given in ESBWR DCD Tables 3A.8.8-1 and 3A.8.8-2, and ESBWR DCD Sections 3G.1.5.2.1 and 3G.2.5.2, which were used for the design of the walls. If site-specific SSI analyses that consider the backfill become available, include the lateral pressures from the SSI analyses in the comparison.

Question: 03.08.05-5

EF3 FSAR Section 3.8.5.5.1, as modified by the markups included with the response to RAI Letter 55 Question 02.05.04-38, indicates that shear failure through the fill concrete below the FSWC is evaluated using shear-friction resistance per the ACI 318 and 349 codes. However, the shear-friction resistance described in these codes assumes yielding of reinforcement through the shear plane, which acts as a clamping force. Therefore, explain whether the fill concrete below the FSWC is reinforced or not. If it is not, explain how the shear resistance is developed. If it is reinforced, describe how the reinforcement is selected.

Request for Additional Information No. 6247

SRP Section: 02.05.04 - Stability of Subsurface Materials and Foundations
Application Section: 2.5.4

Question: 02.05.04-39

In your response to NRC RAI 2.5.4-38 dated June 17, 2011 (NRC3-11-0020), the staff noticed that the ESBWR DCD site parameter requirement $K_0\gamma \geq 47$ lb/ft³ was eliminated for the backfill at the Fermi 3 site from EF3 FSAR Table 2.0-201 and Section 2.5.4.5.4.2. However, this requirement is not redundant with the other ESBWR DCD site parameters for the soil since, for example, a combination of soil density $\gamma = 125$ lb/ft³ and friction angle $\phi = 40$ degrees (equivalent to $K_0=0.35$) satisfy the criteria $\gamma \geq 125$ lb/ft³ and $\phi \geq 35$ degrees, yet $K_0\gamma = 43.8 \leq 47$ lb/ft³. Further, the staff noted that the site-specific ITAAC Item 2 of the engineering properties for backfill adjacent to Seismic Category I structures, including site parameter requirement $K_0\gamma \geq 47$ lb/ft³, was removed from COL Application Part 10: ITAAC, Section 2.4 and Table 2.4.2-1. These engineering properties are independent from the shear wave velocity of the backfill material. Therefore, in accordance with 10 CFR 100.23, please provide the following additional information:

1. The technical basis for eliminating the ESBWR DCD site parameter requirement $K_0\gamma \geq 47$ lb/ft³ from EF3 FSAR Table 2.0-201 and Section 2.5.4.5.4.2.
2. An explanation of why site Design Commitment Item 2 of engineering properties in EF3 COL Application Part 10: ITAAC, Section 2.4 and Table 2.4.2-1 are not applicable, as well as the basis for eliminating Item 2 of site-specify ITAAC corresponding to "backfill adjacent to Seismic Category I structures" from EF3 COL Application Part 10: ITAAC, Section 2.4 and Table 2.4.2-1.